Arnold Schwarzenegger
Governor

DAIRY POWER PRODUCTION PROGRAM

DAIRY METHANE DIGESTER SYSTEM INITIAL EVALUATION REPORT LOURENCO DAIRY

PIER FINAL PROJECT REPORT

Prepared For:
California Energy Commission
Public Interest Energy Research Program

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WESTERN UNITED RESOURCE DEVELOPMENT, INC.

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I. Program Background

The purpose of the Dairy Power Production Program (DPPP) is to encourage the development of biologically-based anaerobic digestion and gasification ("biogas") electricity generation projects on California dairies. Objectives of the program include developing commercially proven biogas electricity systems that can help California dairies offset the purchase of electricity, and providing environmental benefits by potentially reducing air and ground water pollutants associated with storage and treatment of livestock wastes.

The California Energy Commission (Energy Commission), acting under authority of the Legislative enactment in 2001 of SB5X (Section 5(b)(5)(C)(i)), appropriated and encumbered funding for the Dairy Power Production Program (DPPP). Western United Resource Development, Inc. (WURD) was selected by CEC as the Contractor for this program.

To date, a total of 14 projects have been approved for grants totaling $5,792,370. The projects have an estimated generating capacity of 3.5 megawatts.

Two types of assistance were made available for the grant program: buydown grants, which cover a percentage of the capital costs of the proposed biogas system, and incentive payment grants for generated electricity. Buydown grants cover up to 50% of the capital costs of the system based on estimated energy production, not to exceed $2,000 per installed kilowatt, whichever is less. Electricity generation incentive payments are based on 5.7 cents per kilowatt-hour of electricity generated by the dairy biogas system, which totals the same amount as a buydown grant paid out over five years.

The grant program is overseen by an advisory group comprised of representatives from the California dairy industry; California Department of Food and Agriculture; California Energy Commission; California State Water Resources Control Board; Sustainable Conservation; University of California; and U.S. Environmental Protection Agency AgSTAR Program.

II. Dairy Profile

The dairy owner applied for a buydown grant to refurbish an existing covered lagoon digester. The dairy is located in Tulare County on 640 acres. The dairy sits on approximately 100 acres, and the remaining land is used to grow corn, alfalfa, wheat, and cotton, or is leased for cropland.

At the time of this report, there are approximately 2,660 cows on the dairy, including 1,390 lactating cows, 150 dry cows, 20 bulls and 1,100 on-site heifers and calves. An additional 300 calves and heifers are housed off-site.

III. Costs/Funding

The dairy owner was awarded a buydown grant for $114,779 to refurbish an existing, non-operational covered lagoon digester system. It was estimated that the total project costs for the system would be $229,557 of which the dairy owner was eligible for up to 50 percent, not to exceed $2,000 per installed kilowatt. The dairy owner applied for a capacity of 150 kW. The proposed project was for the addition of two floating covers to the lagoon, as well installation of a screen separator for influent liquid manure. During the course of construction, the dairy owner opted to install a total of seven new covers to increase biogas production levels.

To date, 100% of the grant has been paid. As of August 2006, the dairy owner reported having spent approximately $230,406 on project completion. In addition to the $230,406 reported, the dairy owner also allocated approximately $50,000 in personal and dairy labor as well as equipment use for digester-related construction activities.

The dairy owner operates the system himself and expects to spend approximately 10-15 hours per month maintaining the system and monitoring performance. Approximately 15 minutes a day are devoted to digester recordkeeping, and about 10-15 hours a month will be spent on digester maintenance, including oil changes and spark plug replacement, along with other routine maintenance and system repairs. Oil changes are scheduled approximately once a month (assuming the engine runs 24 hours/day). Expected operating costs for oil, oil sampling, spark plugs, air cleaner, valves, filters, and time spent monitoring the system will amount to approximately $500 per month, at minimum. The dairy owner expects to incur additional costs for major engine overhauls every 45,000 hours, or approximately every five years, at an estimated $15,000 per overhaul.

IV. Timeline

The original application was submitted to WURD on September 3, 2002. After thorough screening and due diligence review of the application, the advisory group approved the project for funding on January 10, 2003. It was originally expected that the project would be operational by December 1, 2003. However, due to a number of outside obstacles (as explained below), construction was not completed until January 2006. At that time, the system was capable of producing electricity. However, as of the time of this report, the system is not yet fully operational due to a number of startup and technical difficulties, as outlined below.

V. Outside Obstacles

Low milk prices have had a significant impact on participants in the program. Beginning in late 2001, low milk prices began to put a strain on a dairy farmer's ability to obtain funds to invest in methane digester projects. Prices received by dairy farmers were at the lowest levels witnessed in over 25 years. Though dairy markets are typically cyclical in nature, producers experienced more than 20 months of extremely low prices. These low prices were, in most months, below a dairy producer's cost of producing milk. Prices did not begin to rebound until late 2003.

Another major roadblock to completion of this project was difficulty in obtaining a Rule 21 interconnection permit from Southern California Edison (SCE) so that the project could generate power parallel with the main grid. This process was begun in the summer of 2004, and the dairy owner did not receive a final authorization to interconnect until 2005.

Another obstacle facing this project was the cumbersome and time-consuming process of getting net metering legislation passed in order to allow net electricity generated by a utility customer to be credited against electricity consumed. Although advantageous, this legislation, AB 2228 (Negrete McLeod), was not passed until 2003. After the law's passage, issues with the utility's interpretation of tariffs had to be worked out with the Public Utilities Commission. It should be noted that AB 2228 expired on January 1, 2006; however, new legislation, AB 728 (Negrete McLeod), was signed by the Governor in September 2005. This new bill extends and expands the biogas net metering program through December 2009.

The dairy owner also reported a number of delays in the construction phase. During excavation, the edge of one of the covers was torn, necessitating repair of the damage. In July 2005, the generator was started up and ran on biogas for four hours on two occasions, but the generator was not able to interface with the utility, requiring troubleshooting and repair by the control panel vendor. In January 2006, heavy rains delayed installation of the sixth and final cover. Also, during installation of the muffler and heat exchanger, the muffler was physically dropped onto the gas manifold, which required repair before plumbing on the heat exchanger could be finished. In April 2006, the digester system was again started up, but water was found in low spots in the gas lines. The dairy owner had to dig up and level out some sections of the gas line, as recent heavy rains had settled in certain areas of the gas line trench, allowing water to condense and settle in the low spots. The water in the pipeline restricted the flow of biogas to the engine. In addition, there were problems with the generator shutting off, requiring replacement of the engine shutoff sensor.

The dairy owner also decided to add a regulator to control gas flow and pressure going into the generator. In addition, he had to move his biogas meter, as it had originally been installed after the lagoon covers, where it measured “looped” biogas, meaning that some gas passed around the pipes more than once before going to the generator. To get an accurate reading of biogas produced by the digester, it was necessary to move the biogas meter near the engine where it measures only the biogas used by the engine. A problem with erratic functioning of the engine control system arose in July 2006, causing engine RPM to go up and down. A technician determined that the governor/controller was faulty and needed to be replaced, which was done in August 2006. This did not correct the problem, so the dairy owner is currently awaiting replacement of the main engine controller.

VI. Animal Distribution

At the time of this report, there are approximately 2,660 cows on the dairy, including 1,390 lactating cows, 150 dry cows, 20 bulls and 1,100 on-site heifers and calves. An additional 300 calves and heifers are housed off-site.

The lactating cows are housed primarily in open drylots, spending approximately 19 hours there each day, and about three hours in feed lanes. They spend the other two hours in the milking parlor. The dry cows and heifers spend approximately 21 hours in drylots and three hours in feed lanes. The calves are housed separately.

VII. Manure Collection and Processing

The milking parlor/sprinkler pen and feed aprons are all flushed with either fresh or recycled water two to three times daily. The dairy does not reuse flush water from the lagoon. Instead, water that is used to cool the milk, wash the milk barn, and wash the cows prior to milking is recycled to flush the feed aprons, resulting in the addition of 93,000 gallons of fresh and/or recycled water to the digester each day. There is also one lane that is flushed once per week with an additional 8,000 gallons of water.

The flushed liquid enters a small settling pond to remove any sand that may be present and is then lifted over an inclined screen separator to remove some additional manure solids. The separated solids are used as bedding or for soil amendment on the dairy’s cropland.

VIII. Biogas Utilization System

The screened liquid is discharged to the existing lagoon measuring 1,100 x 90 x 10 feet. The lagoon is fed intermittently six times a day. The hydraulic retention time (HRT) of the lagoon digester is an estimated 53 days. The screened liquid is introduced into the lagoon at an inlet structure located about 190 feet from one end of the lagoon. The liquid manure travels along the length of the lagoon to the outlet located on the other side of the lagoon. The lagoon temperature is not controlled.

Existing lagoon

At the time of grant application, approximately 37,800 square feet (~38%) of the lagoon surface was covered. The purpose of applying for grant funds was to convert the existing, non-operational, partially covered lagoon to an anaerobic digester to produce methane to be used to power an existing synchronous generator. With the addition of the new cover panels, it is estimated that approximately 73% of the surface of the lagoon is now covered. One end of the lagoon was not covered, as this area is not expected to produce appreciable amounts of biogas.

Digester effluents are piped to the final storage lagoon called the “centrifuge lagoon.” From here, digester effluent is used for irrigation where it is applied to cropland at agronomic rates.

IX. Biogas and Energy Production

The covered lagoon is expected to operate as an anaerobic digester producing biogas with an expected methane content of 70%. The dairy owner is currently flaring all biogas produced. A flare meter is not installed, and therefore biogas production figures are unavailable. All biogas produced will eventually be used by the existing 150 kW-capacity Caterpillar 353 generator to produce power for on-farm use. The system design allows biogas that is not used in the engine to be circulated back to the covered lagoon for storage.

It was estimated that the digester would produce 344,553 cubic feet of biogas per day. However, technical due diligence review suggested an estimated 53,250 cubic feet per day of biogas would be achievable assuming a biogas methane content of 70%.

At this time, no biogas is utilized by the engine/generator to produce electricity. In the grant application, an estimated electricity production of 3,222 kWh/day from a total available capacity of 150 kW was expected. Given an estimated average of 3,222 kWh/day, it was assumed that the engine would operate at about 89% capacity.

Unfortunately, monthly utility bills are not available for review and subsequent discussion in this report.

Engine Generator

Therefore, expected revenues from the generation of power cannot be assessed.
The dairy owner will be able to take advantage of the 2005 net metering law, AB 728 (Negrete McLeod), which allows electricity generated by a customer to be credited against electricity consumed. Under the Southern California Edison (SCE) net metering program, an electric meter is used to measure and track the "net" difference between the amount of electricity produced and the amount of electricity consumed during each billing period. This is done on a time-of-use basis according to the customer's rate schedule. Twelve monthly billing cycles commencing on the anniversary date of final interconnection is considered the "relevant period."

At the end of each billing period, a credit is given for energy generated that is in excess of the energy consumed (net generation). Only the generation rate component of the total retail rate is used in the calculation of generation credits. All other charges, including but not limited to, transmission charges, distribution charges, public goods charges, nuclear decommissioning charges, monthly basic service fees, minimum charges, demand charges, and non-energy related charges are calculated prior to the netting of energy supplied or produced, for all energy supplied to the dairy. If energy consumption is greater than the energy produced, the customer is billed the difference. SCE offers the customer an opportunity to "bank" charges for electricity produced in excess of consumption in the form of a credit. This credit can be applied to future generation-related charges on other accounts included in net metering. However, any credits remaining at the end of the 12-month billing period are not paid out by the utility, and are forfeited by the customer-generator. Likewise, any unbilled generation charges that cannot be offset by accrued generation credits must be paid to the utility company.

Total savings from electricity generation at the dairy will likely be a combination of things. For any time-of-use in which electricity production exceeds usage, a generation credit will be accrued, valued at the applicable generation rate. In addition, because the dairy's main load is connected to the generator, the second and largest savings will come from the offset of electricity purchased from the utility company in any given month. However, it must be noted that the magnitude of his savings will be determined by the ability to reduce demand charges. Most of the digester projects are under rate schedules specifying that demand is to be measured in 15 minute intervals. Therefore, any downtime of the system may result in no reduction in demand charges for the month. This reduces the potential savings of on-farm usage of generated power.

This project uses a synchronous generator. The synchronous generator allows the dairy to disconnect from the grid in the event of a power failure and use the generator as a backup electrical source to keep the milk barn operational.

There are five electricity meters on the farm. Of the five meters, one meter is pre-grid (i.e. the load is connected to the generator), and this serves the milk barn. The remaining four meters serve a house, general farming and dairy operations and are net metered according to the net metering provisions explained above.

The dairy owner is hopeful that someday the utility will purchase the excess energy produced on the dairy. However, there are currently no power purchase agreements available to biogas customer generators, and no requirement for the utility to pay the full retail rate for this energy. Net metering is currently the only benefit available to the dairy owner.

X. Energy Usage

As the system has not yet produced electricity, there is no data available on the offset of electricity purchased from the utility. The dairy is wired such that his house, several wells, and the manure handling system will be net metered, and the dairy owner expects to offset most of his energy use once the system is running at full capacity.

XI. System Performance

The system is not yet fully operational. In addition to the construction-related delays and equipment problems outlined above, the dairy owner has noted a number of concerns about his system design and installation, as noted below.

The diameter of the main gas line from the digester to the engine is smaller than would have been ideal. This may restrict the flow of biogas, especially if the grade of the line is not sufficient, as water may settle in the low areas and further restrict gas flow as occurred in April of 2006. Also, the gas blower is located near the engine, but this would have been more ideally located at the digester. The dairy owner pointed out that most other digester projects transporting biogas a distance have their blowers located at the source of the gas. He noted this appears to work better, as it is easier to push the biogas under pressure than it is to move the gas under a vacuum.

The generator type seems to be temperamental in interfacing with the utility grid. This project makes use of a synchronous generator, while most of the other DPPP projects use induction generators. In the event of a power failure, the synchronous generator allows the dairy to disconnect from the grid and use the generator as a backup electrical source to keep the milk barn operational. Induction generators cannot do this. The synchronous generator is therefore more complicated than an induction generator.

Table 1 shows the system design performance calculations. As previously explained, actual performance figures for the 90-day period April-June 2006 are not available and have not been reported by the dairy owner. Due to technical issues, all biogas currently being produced is flared. The flared biogas is not metered, so an estimate cannot be provided.

In the grant application, biogas production was expected to reach 344,553 cubic feet/day. However, as mentioned above, technical due diligence estimated that 53,250 cubic feet/day is achievable from the manure of 1,258 cows, or 42.3 cubic feet/day of biogas per cow. The daily biogas production was estimated to result in electricity generation of 2.56 kWh per cow per day.

Table 1: Digester Design and Actual Performance

	Design	April-June 2006 Average
Cows (lactating)	1,258	1,390
Manure Slurry		
Total gallons per day	140,000	93,000
Digester Specifications		
Type	Covered Lagoon	Covered Lagoon
Digester Feeding Mode	Intermittent – 6x per day	Intermittent – 6x per day
Retention Time (days)	53	53
Gas Production*		
Total (cubic feet per day)	53,250	Not available
Per Cow (per day)	42.3	Not available
Electrical Output		
Generator Capacity (kW)	150 kW	150 kW
Generator Availability (operational hours/day)	21	0
Total (kWh/year)	1,176,000	0
Total per day (kWh)	3,222	0
Total per cow (kWh/day)	2.56	0

* Flared biogas is not metered at this time.

XII. Heat Utilization

The dairy facility uses propane for heating purposes. At this time, the dairy is not utilizing any recovered heat. The engine is outfitted with a heat exchanger, and in the future recovered heat could be used. Currently, the water that is used to wash the cows prior to milking is used to cool the engine. If the dairy owner could recirculate hot water from the generator to heat parlor water for barn cleanup, he could realize additional cost savings could occur.

XIII. Dairy Owner Qualitative Feedback

On a scale from one to four, the dairy owner was asked to rate his experience in a number of areas concerning the digester project. Questions and responses are in Table 2 below.

Table 2: Qualitative Questions

Questions Ranked 1-4, with 1=poor and 4=excellent	**Response**
1. **Ease in operating the biogas production and biogas to electricity systems**	N/A
2. **Extent to which system gives advantage to your dairy manure management**	3
3. **Extent to which the system helps with odor control**	3
4. **Extent to which the system helps with reducing water use for manure mgt.**	1
5. **Extent to which system helps address electricity issues**	N/A
6. **Overall satisfaction with the system so far**	N/A